

## Biological notes on *Nemophora paradisea* (Butler, 1881) (Lepidoptera, Adelidae)

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**Abstract** Daily activity pattern of *Nemophora paradisea* (Butler) was investigated in August and September 1995 at Kanzanji, Shiga Prefecture. The males were found swarming only around sunset. The host plant of *N. paradisea* was found to be *Patrinia villosa* (Valerianaceae). Relationship between the adult emergence periods and male active flying time of some *Nemophora* species in the Kinki district, Japan is briefly discussed.

**Key words** Daily activity pattern, flight behavior, host plant, Adelidae, *Nemophora paradisea*, Japan.

### Introduction

The genus *Nemophora* Hoffmannsegg is a large adelid genus and 24 species inhabit Japan (Hirowatari, 1997). Biological aspects of the Japanese species have been poorly investigated, except for *Nemophora raddei* (Rebel) (Kuroko, 1961) and *N. albiantennella* (Issiki) (Hirowatari and Yamanaka, 1994). *N. paradisea* (Butler, 1881)<sup>1)</sup> occurs in Honshu, Shikoku and Kyushu (Moriuti, 1982) and is known to fly from late August to early September. In this paper, the daily activity pattern and host plant are reported for *N. paradisea*. In addition, the relationship between the adult emergence periods and male active flying time of some *Nemophora* species in the Kinki district, Honshu, Japan is briefly discussed.

### Methods

The field work was carried out along roadside in coppice near Kanzanji, Kinomoto town, Shiga Prefecture, Japan (35°32'N, 136°14'E) on 21 August, 24 August and 1 September 1995. The moths of *N. paradisea* were recorded by two observers slowly walking along the road (ca 50 m) from 0600 to 1900 on 21 August, and 1500 to 1900 on 24 August and 1 September. The moths observed within 2 m both sides of the road were counted as “flying”, “perching” (Figs 1, 2), “nectaring” (Fig. 3) and “ovipositing” (Fig. 4). The temperature and light intensity were measured every hour. The study site (Figs 5, 6) was surrounded by coppice which mainly comprises *Quercus serrata* (Fagaceae) and *Pinus densiflora* (Pinaceae), and the roadside was covered dominantly with such herbal plants as *Boehmeria tricuspis* (Urticaceae), *Reynoutria japonica* (Polygonaceae), *Artemisia princeps* (Compositae) and *Pueraria lobata* (Leguminosae). Flowering plants were relatively scarce in the study period other than some

<sup>1)</sup> This species was recently synonymized with *N. decisella* (Walker, 1863) by Kozlov & Robinson (1996). But based on our unpublished data, this species is also distributed in South-east Asia and occurs sympatrically and simultaneously with *N. decisella* in some areas. Since the Japanese representative is, thus, considered a distinct species, here we tentatively retain the name *paradisea*.



Figs 1-6. Study site and the adults of *Nemophora paradisea* (1 September 1995). 1-2. Perching male. 3-4. Nectaring and ovipositing females on *Patrinia villosa*. 5. Study site. 6. Roadside herbs above which males of *N. paradisea* performed swarming.

flowers of *Eupatorium chinense* (Compositae) and *Patrinia villosa* (Valerianaceae) on 1 September.

## Results

### 1. Flying activity and precopulatory behavior

Daily behavioral patterns of the adults of *N. paradisea* are shown in Figs 7, 8. Neither flying individuals nor perching ones were observed in the daytime (1100–1500) on 21 August. Males were observed actively flying and swarming only around sunset under low light intensity from 2,000 to 10,000 lx. The swarms were performed by a maximum of five individuals interacting with one another at a height of *ca* 1–2 m, that is, 20–30 cm above the top of herbage consisting of *Boehmeria tricuspis* and *Pueraria lobata*, etc. The swarms moved and did not persist above the same plant species. In the morning of 21 August, some males were found flying or perching on the leaves but they did not swarm. Around 1400 of 21 August, when it rained, light intensity descended momentarily under 5,000 lx, but no flying males were seen. On 24 August, a mating pair was found on a leaf of *B. tricuspis* at 1830

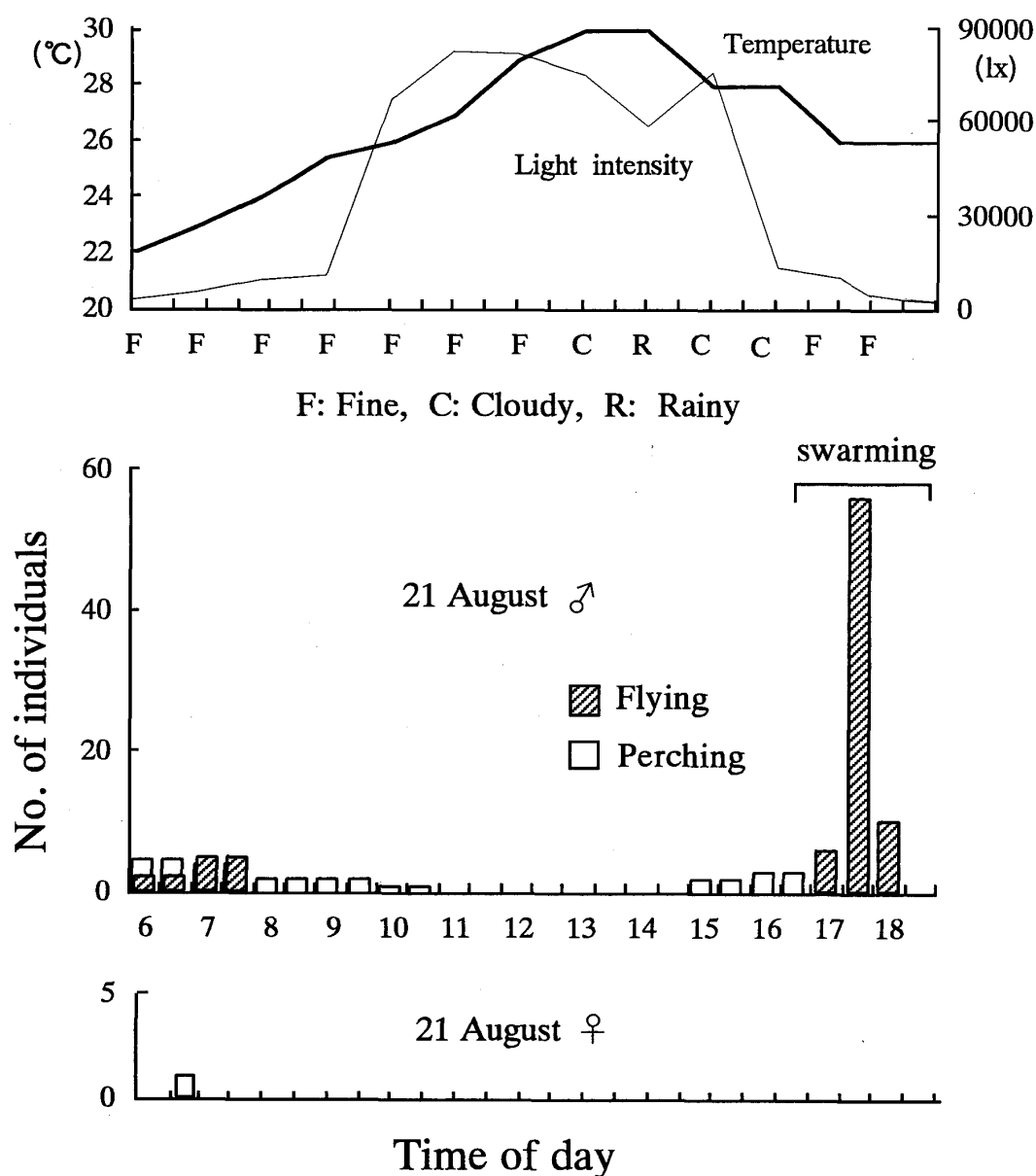


Fig. 7. Daily activity pattern of *Nemophora paradisea* recorded on 21 August 1995.

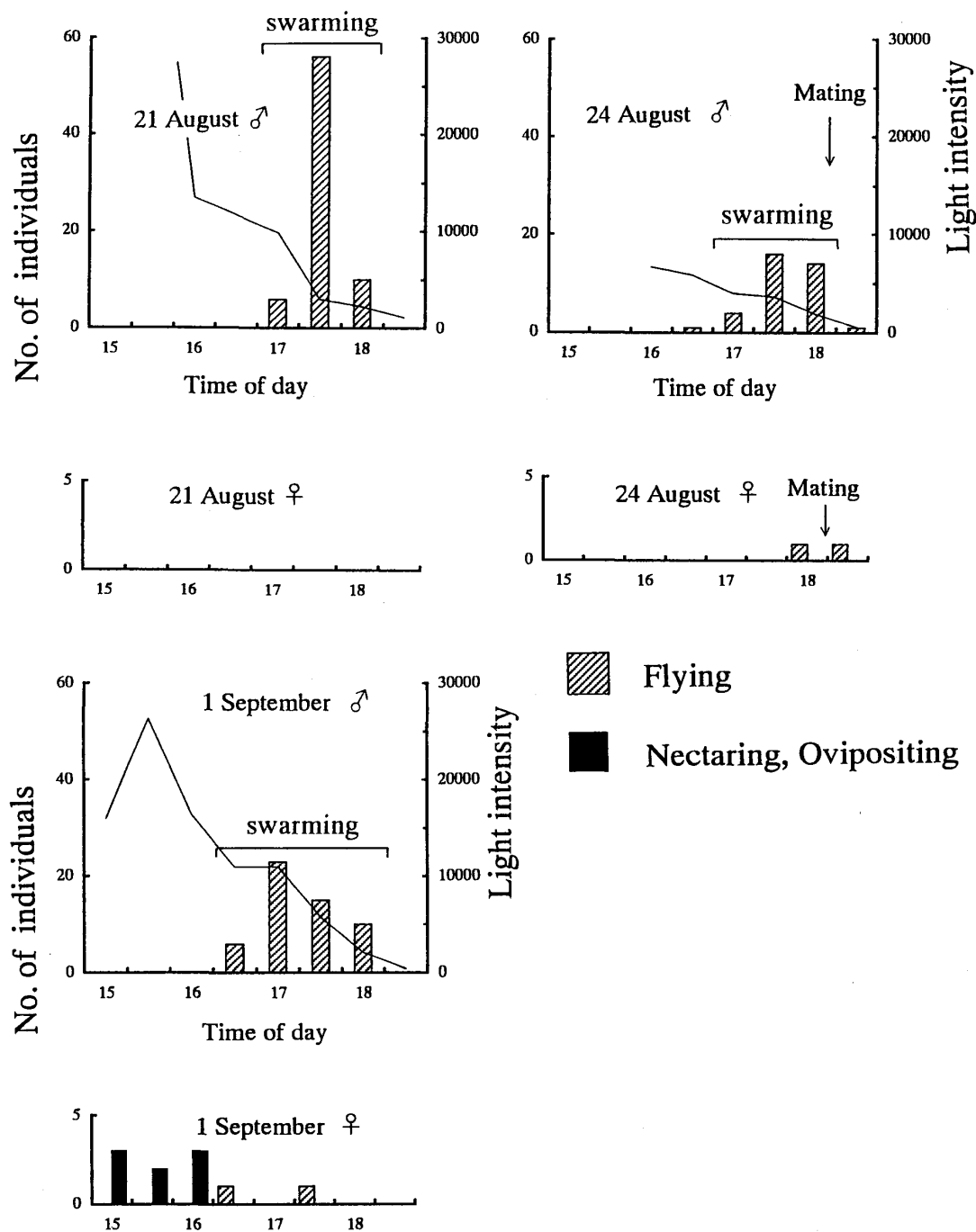


Fig. 8. Daily activity pattern (1500-1900) of *Nemophora paradisea* recorded on 21, 24 August and 1 September 1995.

(21°C, 420 lx), but we could not observe precopulatory behavior of the female.

## 2. Adult feeding activity, oviposition and host plant

Throughout the study period, no male of *N. paradisea* was observed to visit flowers. However, some females were observed to visit flowers of *Patrinia villosa* (Valerianaceae) on 1 September. In addition, we found that *N. paradisea* also utilizes it as host plant. As mentioned above, both sexes were not found in the daytime on 21 and 24 August; however,

on 1 September the females were found nectaring and ovipositing repeatedly at 1500–1600, preceding the male swarming (1630–1830). A total of seven females was observed nectaring on flowers of *P. villosa* and penetrating the ovipositor into the flower buds. They perched on the flowers apparently for a long time ( $43.6 \pm 25.3$  min.,  $n=7$ ). Exceptionally one female was observed to visit the flower of *Eupatorium chinense* (Compositae) and stayed for *ca* 10 min., but oviposition was not observed.

## Discussion

### 1. Precopulatory behavior

*N. paradisea* is found here as a “swarming species” *sensu* Kozlov (1987). The swarms were seen above some herbs, such as *B. tricuspis* and *P. lobata*. The swarming males seem to utilize some herbs of a height of about 1 m as a marker but they seem not to select plant species. Judging from the observation that the mating pair was found on the leaf of *B. tricuspis* after sunset, copulation of this species is considered to take place during the male swarming. As Kozlov (1987) noted for the swarming species, the female probably entered the swarm before copulation.

### 2. Nectaring and ovipositing

Nectaring and ovipositing individuals were only seen on 1 September, while these behaviors were not observed on 21 and 24 August. It should be noted that the flower buds of the host plant *Patrinia villosa* were not developed on 21 and 24 August. The females seem to synchronize ovipositing with the flowering period of the host plant. The long perching time of the *N. paradisea* females on the flowers of *P. villosa* is probably because the moth utilizes *P. villosa* as both a nectaring resource and host plant. In addition, it is also because other flowering plants around the study site were rather scarce. Unless disturbed by other insect visitors, most of the females seem to have stayed on the flower much longer. In this study, nectaring of the males was not observed, but the behavior of the males should be confirmed by further observation.

### 3. Emergence period and active flying time

Emergence period of adults of *Nemophora* species depends on the altitude and latitude of the habitat even in the same species. Fig. 9 shows the adult emergence periods and male active flying time of four *Nemophora* species, *N. raddei*, *N. albi antennella*, *N. rubrofascia* and *N. paradisea*, in rather low to middle altitude (*ca* 100–1,100 m) of the Kinki district, Honshu, Japan. In the spring or early summer species, the moths actively fly (and swarm in the swarming species) in the daytime, but in the summer species, they tend to fly later in the afternoon when the temperature is moderate and the light intensity is relatively low.

To our knowledge, there are no species which actively fly (and swarm) in the daytime of clear hot weather in late July to August at low altitude of the Kinki district, Japan. Kozlov (1987) noted on the basis of observation in the Maritime Territory, Russia at the end of July–beginning of August that *Nemophora askoldella* swarms frequently in the evening before sunset but in cloudy weather it swarms the whole day long. One of us (Hirowatari) observed the males of *Nemophora rubrofascia* swarming above the flowers of *Hydrangea paniculata* (Saxifragaceae) around 1700 (*ca* 10,000 lx) on 3 July 1994 at Mt Wasamatayama (alt. 1,000 m). *N. rubrofascia* was also actively flying when it was cloudy and foggy around 1500 (*ca* 10,000 lx). The flying activity of *Nemophora* species seems to be affected by weather

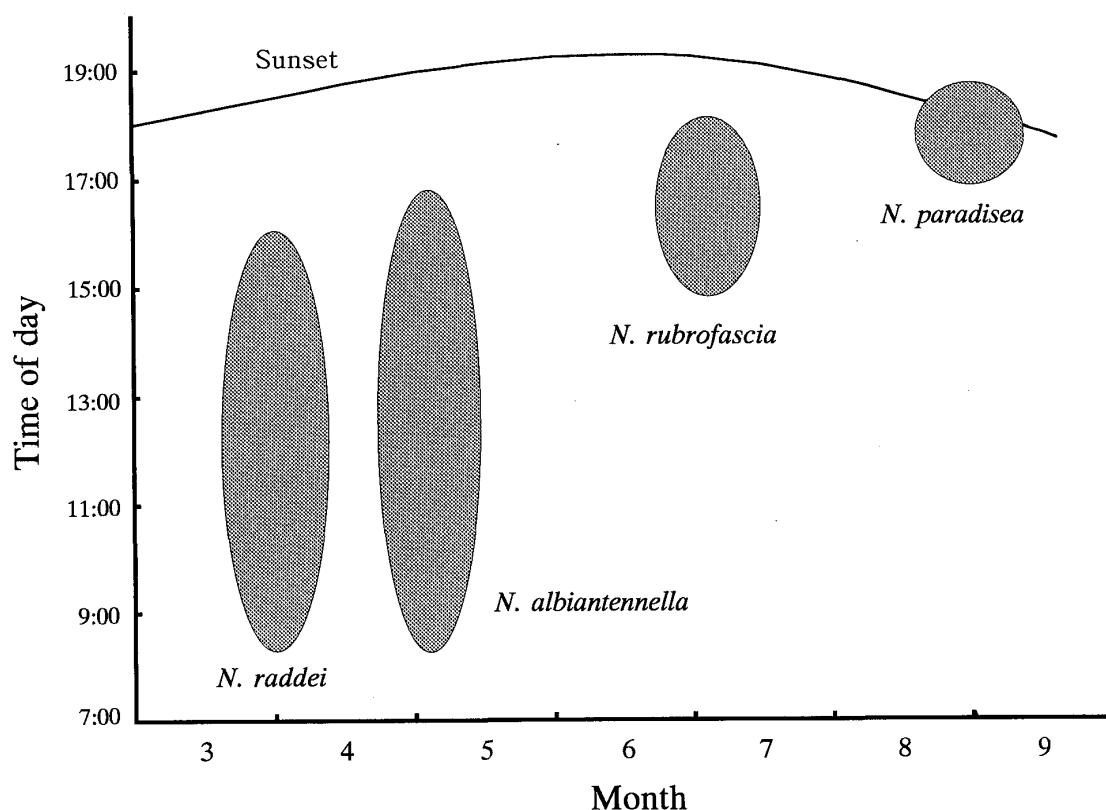


Fig. 9. Emergence periods and male active flying time of four *Nemophora* species in the Kinki district, central Honshu, Japan.

conditions. However, in the present study, the male swarming of *N. paradisea* was observed only in the evening around sunset in spite of light intensity descent in the daytime. Thus, the daily activity pattern of *N. paradisea* is possibly controlled by circadian rhythm, but analysis of diversification of the daily activity pattern of *Nemophora* species needs accumulation of further observation data.

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## 摘 要

ヒロオビヒゲナガに関する生物学的知見 (広渡俊哉・永池徹也)

ヒロオビヒゲナガ *Nemophora paradisea* (Butler) は、本州、四国、九州に分布し、成虫が8月に発生することが知られているが、その生活史や飛翔活動の日周期性についてはまったく知られていなかった。そこで、本研究では、本種の生活史の一部を明らかにすることを目的とし、その日周活動パターン、産卵寄主などを調査した。調査は、1995年8月21日、8月24日、9月1日に、滋賀県木之本町管山寺付近の林道沿いで行った。分類学的には、本種 *N. paradisea* は、最近 Kozlov and Robinson (1996) によって、*N. decisella* (Walker) (基産地はスマトラ) のシノニムとされたが、これについては再検討が必要であると思われるので、ここでは *paradisea* を用いた。

調査の結果、成虫、特に♂の飛翔時間は日没前後に集中し、アカソなどの草本の上空で群飛(スウォーム)を行うことが明らかになった。群飛は8月21日、8月24日、9月1日のすべての調査日で確認された。8月24日の日没後には1例だけ交尾個体が観察された。また、9月1日には♀成虫がオミナエシ科のオトコエシ *Patrinia villosa* の花のつぼみに産卵するのが観察され、本種の寄主植物がはじめて明らかになった。♀はオトコエシを吸蜜源としても利用しており、長時間(43±25.3分,  $n=7$ )にわたって産卵・吸蜜を繰り返していた。また、♂の吸蜜行動はまったく観察されなかった。

ヒゲナガガ科において♂が群飛する種では、♀が群飛の中に飛び込んで交尾が成立すると考えられている(Kozlov, 1987)が、♂の群飛後に交尾個体が観察されたことから、ヒロオビヒゲナガでも同様の配偶行動を行っている可能性が高い。8月21日、8月24日にはオトコエシはまだ開花していなかったこと、9月1日にはほとんどの♀が開花したオトコエシの花のみを吸蜜源として利用し産卵を繰り返していたことから、♀は産卵時期をオトコエシの開花時期と同調させていると思われる。

また、日本(近畿)産のヒゲナガガで、春季に出現するゴマフヒゲナガやクロハネシロヒゲナガでは、ほぼ終日活発に飛翔するのに対して、夏季に出現するベニオビヒゲナガや今回扱ったヒロオビヒゲナガなどは活動時間帯が夕刻にずれる傾向があることを示した。ウスベニヒゲナガ(*Nemophora*)属の日周活動パターンを明らかにするには、今後さらに多くの種でデータを蓄積する必要がある。

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